NESC Initial Technical Activities Yield Lessons for Agency

Cloud-Aerosol LIDAR and Infrared Pathfinder Satellite Observation (CALIPSO) Spacecraft

The Cloud-Aerosol LIDAR and Infrared Pathfinder Satellite Observation (CALIPSO) spacecraft is a joint science mission among the Centre National d'Etudes Spatiales, Langley Research Center, and Goddard Space Flight Center. The Earth Science satellite mission is scheduled for launch on a Boeing Delta II rocket from Vandenberg Air Force Base in 2005. Concerns raised about the hydrazine-fueled spacecraft propulsion bus led to the NESC providing a review of the bus design and an assessment of the potential for personnel exposure to hydrazine propellant. During the NESC review of the propulsion bus design, it became evident that concerns about early design decisions were still prevalent, even though the bus assembly was already completed. Contributing to these lingering concerns were the different interpretations of an ambiguous requirement for fault tolerance by each organization involved. Following the assessment, the NESC issued a final report outlining 11 requirements for the CALIPSO project to address in order to ensure the risk to personnel is acceptable.

Lesson: NASA must establish unambiguous requirements for fault tolerance.

Lesson: In the design phase of a project, a thorough risk assessment must be performed to ensure a configuration that provides the overall minimum risk to personnel, the mission, and the environment. While current NASA policy does require a risk assessment, it is important to include all stages of project development when evaluating any potential hazards, including ground processing and integration.

Lesson: At the beginning of a project involving outside partners, NASA must clearly define and document its expectations, including the standards, specifications, and processes that should be followed by all parties.

X-43A

The X-43A is a prototype, hypersonic aircraft mounted on a modified Pegasus booster rocket that accelerates the X-43A to its test speed and altitude. The modified Pegasus/X-43A stack is launched from the NASA B-52B aircraft. The NESC received a dissenting opinion describing aerodynamic concerns leading to a potential loss of vehicle control that would result in a failure to achieve mission objectives. Working in conjunction with the X-43A project, the NESC ensured that the aerodynamic issues were properly addressed through the existing independent Flight Readiness Review (FRR) process. The role of the NESC was to confirm that the independent FRR committee adequately reviewed, investigated, and responded to the dissenting opinion. The NESC concluded that the FRR process used by Dryden Flight Research Center for the X-43A provides a more robust review process than the single meeting method used by many programs.

Membership for the committee is established independently of the program and comprises the necessary technical expertise required to provide a thorough assessment. The committee reviews the readiness of the project at several stages prior to flight, allowing adequate response time for FRR initiated actions and appropriate follow-up on identified technical issues. This process also provides a mechanism for receiving and resolving dissenting opinions and can draw upon expertise and skills from across the Agency. Adequate and thorough assessment of dissenting opinions can produce a better understanding of engineering data, leading to either modification or reaffirmation of the risk assessment for safety and mission success.

Lesson: Dryden Flight Research Center's Flight Readiness Review process (Dryden Handbook DHB-X-001) provides for a robust, independent review of a project's readiness for flight and should be adopted across the Agency.

Lesson: The NESC is implementing a strategy for addressing dissenting opinions. Other organizations within NASA need to develop strategies for handling dissenting opinions.

Space Shuttle

The space shuttle orbiter rudder/speed brake system provides steering and braking for the orbiter during landing. After the decision was made to replace the rudder/speed brake actuators with spares that had been in storage, concerns were raised on the potential breakdown of grease because the storage time exceeded the original certified life. The NESC conducted extensive testing and performed analyses to determine that separation of the grease did not adversely affect its lubrication properties. The NESC recommended that the stored actuators were safe for use on orbiter Discovery.

Lesson: Programs should periodically review hardware components to ensure that they are operating within qualification and certification limits. When hardware exceeds these limits, testing or analysis should be performed to properly envelop the actual operational environment.

Mars Exploration Rovers

The Mars Exploration Rovers (MER), Spirit and Opportunity, were designed to geologically explore the surface of Mars. Prior to the rovers' landings on Mars, the NESC provided technical expertise in support of two MER reviews. The first included a human factors review of ground operations. Because Martian and Earth days differ in length, the staff and mission scientists must cover work periods around the clock that change in start time by 40 minutes each day. In preparation for Opportunity's landing, the NESC also supported the MER data review process of Spirit's entry, descent, and landing phase. Deviations from the expected angle of attack of the entry vehicle during entry, descent, and landing for Spirit and Opportunity raised several issues potentially relevant to future planetary missions. Instrumentation currently flown (or planned for future missions) is not adequate to distinguish the separate effects of density and drag coefficient errors on aerodynamic forces encountered during entry, descent, and landing.

Lesson: Implement the work time limits for critical operations across the Agency as outlined in NASA Procedural Requirement 1800.1.

Lesson: Future planetary missions should include instrumentation to assess entry performance and fully characterize the environment encountered during entry, descent, and landing.

Technical Documentation

During review of technical work that had been previously performed by a project, the NESC found it difficult to reconstruct the evidence and rationale because the majority of the available documentation was in PowerPoint presentation format. While PowerPoint may be a good tool for presenting high-level information, it does not provide substantive historical documentation of engineering results.

The NESC has participated in training from Edward Tufte of Yale University, whose analysis of the PowerPoint slides used during the STS-107 mission was cited in the Columbia Accident Investigation Board report. Tufte recommends a narrative format and high content text over the PowerPoint method of information exchange.

Lesson: Engineering organizations should use reports to document technical results. The NESC's final products will be engineering reports.

Lesson: The emphasis should always be on content— not format—regardless of whether PowerPoint or an engineering report is used for communication.

Other NESC activities:

- Assessment of shuttle flowliner concerns
- Assessment of orbiter rudder/speed brake gear margins
- Independent review of space shuttle and space station recurring anomalies
- Providing independent expertise for Cassini Saturn Orbit Insertion Critical Events Readiness Review

For more information on the NESC, or to report a technical concern, please visit our website: **http://nesc.nasa.gov**

Trending Analysis Activity

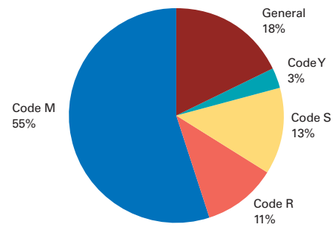
The NASA Administrator has challenged the NESC to improve the Agency's trending capability to proactively seek out potential technical problems or deficiencies in NASA's programs, projects, or institutions. Because there are numerous disparate databases, with no consistent format or data classification system, the task of trend analysis is daunting at best. Having a single system or tool for use across the Agency is not required as long as all programs and projects follow a single set of standards. Such standards do not currently exist within the Agency.

Lesson: Establish Agency standards and best practices for data collection and the corresponding data taxonomy.

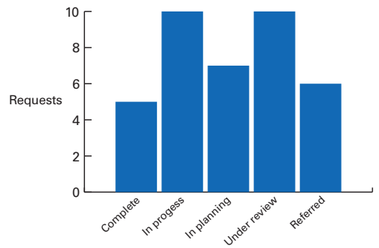
NESC Metrics

While the NESC's current focus is on a successful space shuttle return to flight and the International Space Station, we are involved in other activities across the Agency. Requests and concerns are coming into the NESC on a regular basis where they are reviewed, evaluated, and dispositioned. The NESC is currently working on a number of activities with additional items either in planning or review stages.

NESC Requests by NASA Enterprise (through March 31, 2004)



Status of NESC Request Activities (total of 38 requests through March 31, 2004)



Recognition Corner

To recognize outstanding contributions to NESC's sponsored activities, and to encourage critical examination of engineering problems, the following awards have been established. These awards will be presented at each of the quarterly leadership briefings:

NESC Director's Award
Honors individuals who take personal accountability and ownership in initiating clear and open communications on diverse or controversial issues. A key component of this award is based on the process of challenging engineering truths.

NESC Engineering Excellence Award
Honors the accomplishment of NESC job-related tasks of such magnitude and merit as to deserve special recognition.

NESC Leadership Award
Honors individuals who have had a pronounced effect upon technical activities of the NESC.

NESC Group Achievement Award
A team award given to a group of employees comprising both government and nongovernment personnel for outstanding performance through the coordination of individual efforts that have contributed substantially to the accomplishment of the NESC mission.

NASA Engineering and Safety Center

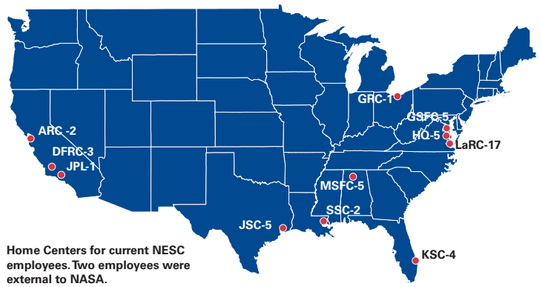
Leadership Brief: Volume 1, May 2004

What is the NASA Engineering and Safety Center?

The NASA Engineering and Safety Center (NESC) is chartered to serve as an Agency-wide technical resource focused on engineering excellence. The objective of the NESC is to improve safety by performing in-depth independent engineering assessments, testing, analysis, and evaluation to uncover technical vulnerabilities and to determine appropriate preventive and corrective actions for problems, trends, or issues within NASA's programs, projects, and institutions. The NESC draws upon the best engineering expertise from across the Agency and includes partnerships with other government agencies, national laboratories, universities, and industry.

The NESC operates as a true One NASA organization by engaging all NASA Centers and Headquarters in the mutual goal of increasing safety through engineering excellence.

The Associate Administrator for Safety and Mission Assurance and the NASA Chief Engineer jointly establish direction and provide guidance for the NESC. The NESC gains its independence through two means. First, the NESC is funded through the Associate Administrator for Safety and Mission Assurance. Second, the NESC provides an independent line of communication to ensure that all NASA employees have an alternate path to report technical concerns and to encourage consideration of all points of view on critical technical issues.



Home Centers for current NESC employees. Two employees were external to NASA.

NESC Communication

The primary purpose of this publication is for the NESC to share those lessons learned from our efforts that we believe are broadly applicable to NASA organizations and programs. The NESC is also conducting quarterly leadership briefings to discuss these lessons with the Agency's senior leadership, who are in the positions to implement change within their own organizations. These briefings have been modeled after a similar concept used by the U.S. Navy Board of Inspection and Survey (INSURV).

NESC: A One NASA Organization

When diversity in expertise is applied to a challenging task, most—if not all—issues can be resolved. With members from across the Agency, the NESC has demonstrated how diverse experiences can be used to challenge technical biases and assumptions, resulting in a better overall product. Programs and Centers should strive to take full advantage of the Agency's resources rather than being limited to what is available within their own organizations. The NESC had to work through a number of administrative issues during formulation of the organization. Across the Agency, we should continue to improve the administrative processes in order to fully realize the potential of One NASA.